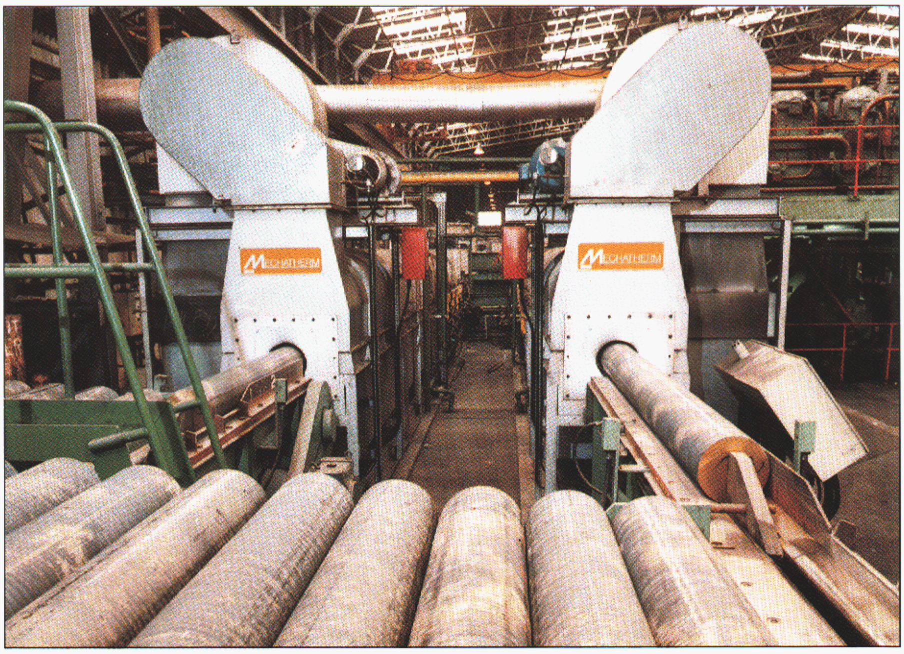
# Case Study 162

## Higher efficiency motors on fans and pumps




*Mecatherm furnace*

### Case Study Objective

To demonstrate the savings that can be made by using higher efficiency motors.

### Potential Users

Industry and commerce where electric motors are running for long periods.

### Investment Cost

The total marginal cost between the five higher efficiency motors and standard motors was £670 (1992 prices).

However, some motors are now available which offer higher efficiency without any price premium.

### Delivered Energy Savings

11.66 MWh/year (42 GJ/year), worth £408/year (1992 prices).

### Payback Period

1.64 years (1992 prices). If currently available higher efficiency motors without any price premium had been available at the time of this project, the paybacks would have been immediate.

### Case Study Summary

Higher efficiency motors are usually justified in applications where a motor, which is new or requires replacement, is running for long periods at high load. The cost premium in such cases can normally be recovered within two years by the extra efficiency these motors offer over standard motors.

At Delta Extrusion five motors were replaced with higher efficiency motors to give a reasonable cross section of the range of cast iron motor ratings. Three of the motors were running continuously; the remaining two ran on a 5-day, 3 shift operational pattern.

Measurements of average load and data on motor efficiency were used to compare the running costs of the new higher efficiency motors with the equivalent standard motor. A comparison was also made with the running costs of the motors which had originally been installed.

### Host Organisation

Delta Extruded Metals Company Limited
Greets Green Road
West Bromwich
West Midlands
B70 9ER

### Equipment Supplier

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HD1 3LJ
Tel No: 01484 422150

### Monitoring Organisation

The Clifford Talbot Partnership
206 Penn Road
Wolverhampton
West Midlands
WV4 4AA
Tel No: 01902 659659
Mr S J Clifford

### Supporting Organisation

Copper Development Association

There may be other suppliers of similar energy efficient equipment in the market. Please consult your supply directories or contact ETSU who may be able to provide you with more details.

*"... higher efficiency motors can be justified as cost effective ..."*

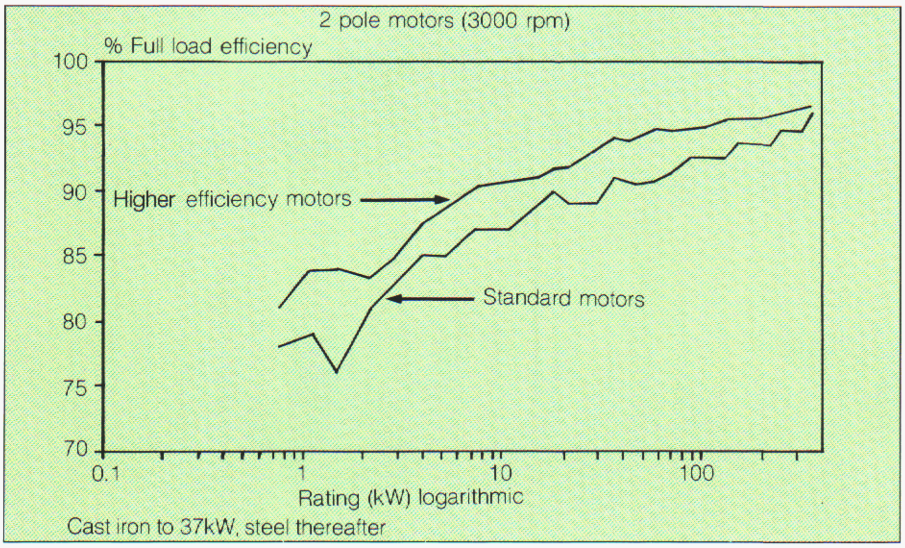
BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

## Background

Higher efficiency motors are usually manufactured from a higher quality material than standard motors. More care is also taken with the design and geometry of the motor construction. The higher efficiency motors used in this project have been improved in four areas which results in their higher running efficiencies:

- Longer core lengths of low loss steel laminations reduce flux densities and iron losses.
- Copper losses are reduced by maximum utilisation of the slots and by providing generous conductor sizes in the stator and rotor.
- Stray losses are minimised by careful selection of slot numbers and tooth/slot geometry.
- A more energy efficient motor generates less heat so the cooling fan size is reduced. This leads to lower windage losses and therefore less wasted power.




***Comparison of full load efficiencies***

## Motor Selection

The motors selected for comparison on this project were chosen for their long running hours and to provide a reasonable cross section of the range of cast iron higher efficiency motors.

| Motors tested | | | | |
|---|---|---|---|---|
| **RATING (kW)** | **RPM** | **FRAME SIZE** | **APPLICATION DESCRIPTION** | **RUNNING HOURS/YEAR** |
| 30.0 | 1465 | D200L | Mecatherm billet reheat furnace exhaust fan | 4704 |
| 18.5 | 2950 | D160L | Mecatherm billet reheat furnace combustion air fan | 4704 |
| 7.5 | 2870 | D132S | Induction furnace cooling fan | 8760 |
| 5.5 | 2870 | D132S | Induction furnace coil cooling pump | 8760 |
| 1.1 | 2800 | D80 | Induction furnace capacitor pump | 8760 |

The table details the selected motors, their application and their running hours.

## Installation

The installation of the new motors was a reasonably simple undertaking as the mounting feet and fixing holes are identical to those of the standard motor. The table below shows the differential cost between the higher efficiency motors and the standard motors equivalent for 440 V operation, 440 V being the standard voltage at this site. Installation costs, labour etc, are not included as these would have been incurred whether a new standard or higher efficiency motor was fitted.

The higher efficiency motors are longer at the non-drive end. However this did not cause any problems on the installations at Delta Extrusion

| MOTOR RATING | DIFFERENTIAL COST |
|---|---|
| 30.0 KW | £271.60 |
| 18.5 kW | £179.90 |
| 7.5 kW | £ 94.50 |
| 5.5 kW | £ 85.40 |
| 1.1 kW | £ 36.89 |
| **TOTAL** | **£668.29** |

## Methods of Tests

The power consumption of each motor was monitored with clip-on current transformers to measure individual phase currents. Voltage probes on each phase enabled measurements of apparent power (kVA), true power (kW), and therefore power factor, to be made.

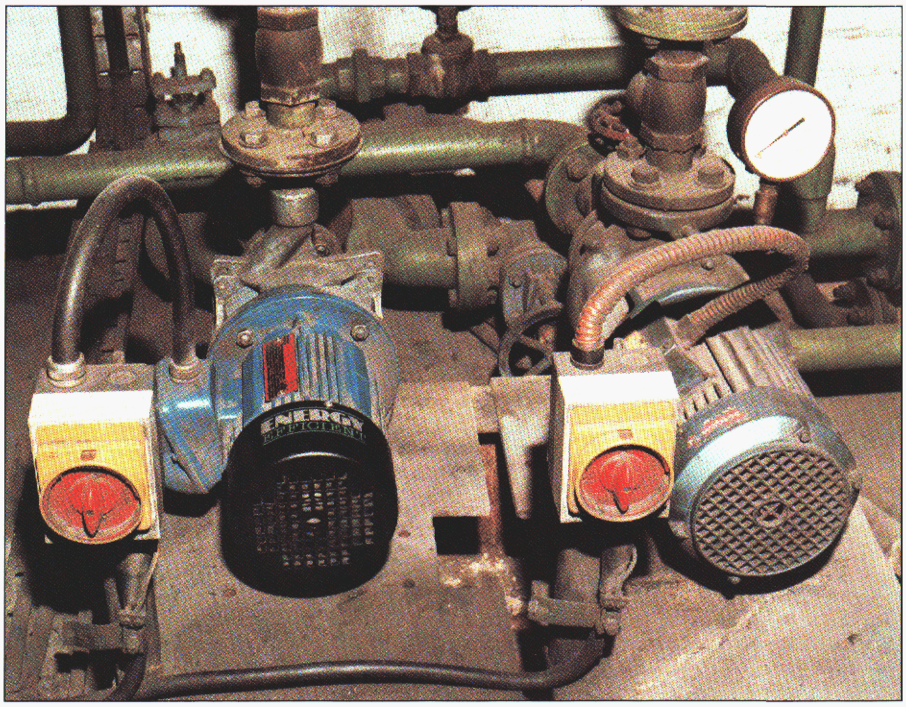
Monitoring periods of 30 minutes were set up on the system to mimic the supply authorities charging periods. Each phase was sampled every second and the readings averaged over the monitoring period.

Each motor was monitored for one week to ensure that the complete production pattern was monitored.

## Comparison with New Standard Motors

In the majority of cases the use of higher efficiency motors should be considered for new plant or when an existing motor is to be replaced. The comparison will therefore be between a new standard motor and a new higher efficiency motor.

To demonstrate the savings available, calculations have been carried out using the monitored power input to the higher efficiency motors and motor test certificate information to calculate the mechanical load on the shaft.

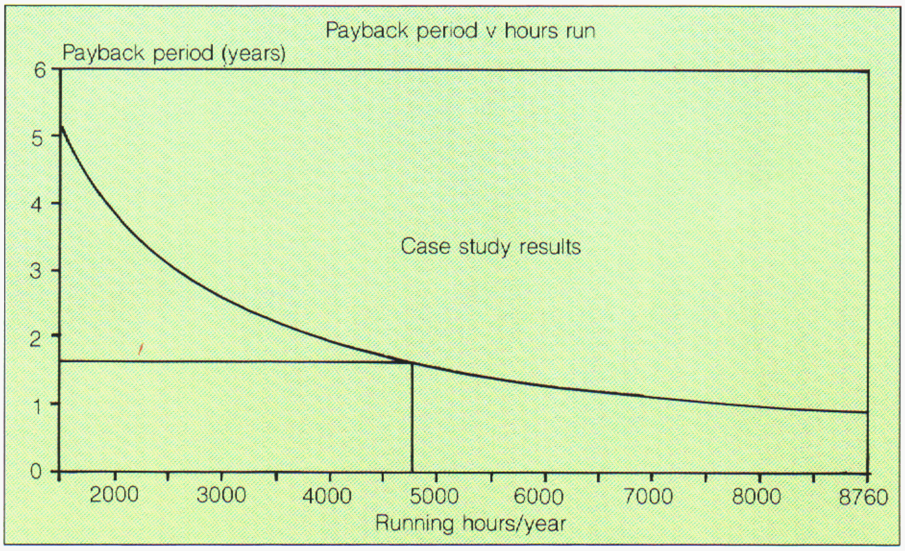


***1.1 kW induction furnace cooling pump motors***

The energy consumption of a new standard motor with an identical mechanical load was calculated and hence the energy savings. Previous independent motor tests by the Energy Efficiency Office (EEO) have demonstrated close agreement of motor tests with type test results. Type tests on an individual motor provide specific data on a motor's efficiency and can be requested from the manufacturers.

### Summary of Savings

The electrical energy savings are converted into financial savings by applying an average electricity cost of 3.5p/kWh. This figure is the average annual electricity cost to Delta Extrusion. The figure is built up from the pool price which fluctuates with demand over each half hour during the year. The average of 3.5p is, therefore, made up of 17,520 individual half hour costs and includes transmission and availability charges.




***18.5 kW motor***

These results show that the best paybacks are achieved on the motors which run for long hours at higher loads. It is also apparent that some of these motors appear to be oversized for their applications.

Measurements were also taken on the original motors before installation of the higher efficiency motors. The most notable feature when comparing the measurements is the load variation. As mechanical loading varied between the two test periods, due to production fluctuations and rebalancing of fans, the effect of the higher efficiency motor is difficult to establish directly. Further, the efficiencies of the original motors was unknown. However, where loading of the new and old motors are similar, paybacks agree well with predictions from the type test certificate.

### Additional Potential Savings

Additional benefits include the improved power factor of each higher efficiency motor, for example the power factor of the 30 kW motor improved to 0.78 from 0.55.

However, the benefits depend upon the electrical tariff in use and the amount of central power factor correction equipment.

***Table of Savings Summary***

| Rating (kW) | Average load (%) | Running hours | Savings (£) | Premium (£) | Payback period (years) |
|---|---|---|---|---|---|
| 30.0 | 49 | 4,704 | 80.67 | 271.60 | 3.37 |
| 18.5 | 27 | 4,704 | 110.38 | 179.90 | 1.63 |
| 7.5 | 87 | 8,760 | 76.65 | 94.50 | 1.23 |
| 5.5 | 60 | 8,760 | 110.38 | 85.40 | 0.77 |
| 1.1 | 77 | 8,760 | 30.66 | 36.89 | 1.20 |
| **TOTALS** | | | **408.74** | **668.29** | **1.64** |

On many sites the benefit in improved power factor would result in financial savings. For example, on a site with a maximum demand tariff, the lowered kVA would result in additional savings of £380/year.

Alternatively where excess reactive power is charged for, additional savings of £200/year may be achieved. Such savings would improve the payback significantly.

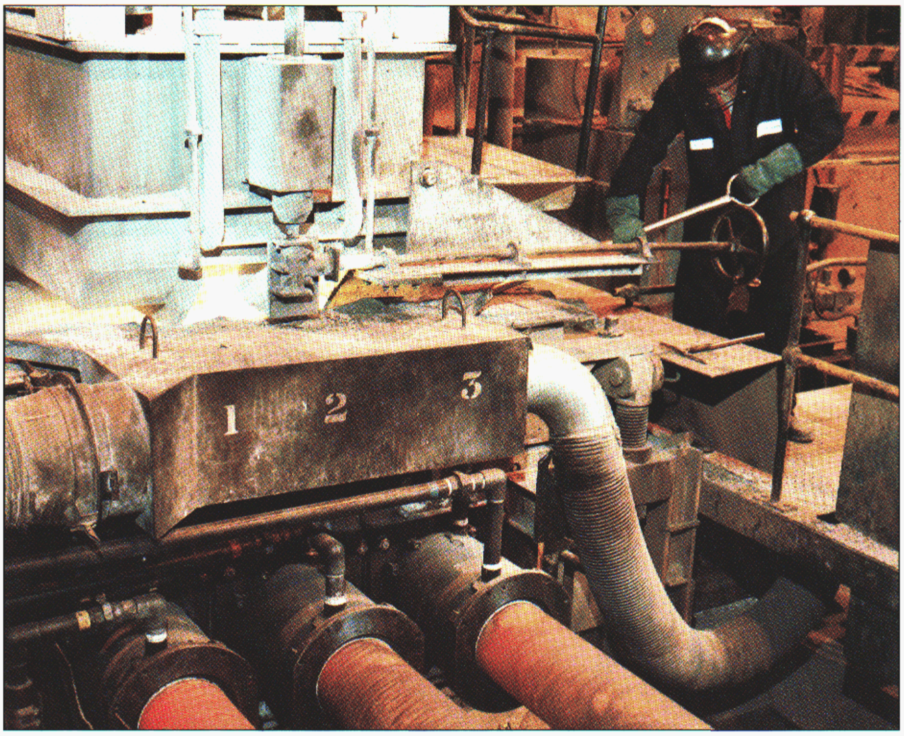
### Conclusions

Overall the savings achieved from the fitting of higher efficiency motors provided paybacks on the differential cost between standard and higher efficiency motors, of between 9 months to 3.4 years. Across the group of five motors the savings were £408.74 with a payback of 1.64 years. Thus higher efficiency motors can be justified as cost effective where a motor is new or requires replacement.

As Delta Extrusions is a large organisation it benefits from being able to negotiate cheap electricity costs and also discounts when purchasing electrical motors etc. Care must therefore be taken when generalising on payback periods for higher efficiency motors as other users will undoubtedly have different costs in both electricity and capital purchasing areas.

Bearing this in mind, as a general rule the differential cost of the higher efficiency motor will be returned within two years if the motor is running on high load with long running hours. This payback period is considered as reasonable for energy conservation programmes.

When considering the use of higher efficiency motors it is essential that basic information such as the number of hours the motor is running per year and the average and peak electrical load of the motor is known before the decision is taken to fit higher efficiency motors.




***Induction furnace and hot billets***

**Comments from Delta Extruded Metals Company Limited**

As a considerable user of electricity, we are constantly exploring any means of reducing consumption to offset the ever increasing costs.

Although motors do not form the largest portion of our connected load, it was felt that an association with the Energy Efficiency Office would be very worthwhile in order to evaluate the energy and financial savings by monitoring motors under operating conditions.

- The motors achieved savings generally in line with those claimed by the manufacturers and, with projected electricity prices, may exceed the claims.
- When specifying new plant, the use of higher efficiency motors warrants serious consideration.
- When it becomes necessary to purchase a new motor as a replacement, the use of a higher efficiency motor may have financial benefits.
- Although power factor improvements were not of major importance during this particular project, there could be major benefits for users with a large connected motor load.

The use of higher efficiency motors is worthy of consideration for all applications where the motor is operating at high loads for long periods. Financial savings can be made with a payback period which is reasonable for an energy conservation programme.


***Delta Extruded Metals Company Limited***

Delta Extrusion, part of Delta plc, operates from two production sites in the heart of the West Midlands. Both sites are designed and planned for the efficient manufacture of high quality semi-finished brass products.

Rods for free machining and hollow bar are produced at Wolverhampton, whilst the West Bromwich site accommodates rods for forging, profiles to customers own drawings, copper and brass wire. The West Bromwich site also houses a modern horizontal casting plant for in-house billet supply, as well as the administration base.

Extrusion presses ranging from 1,200 to 2,500 tonnes provide a finished capacity in excess of 60,000 tonnes/year; enough to satisfy over two thirds of the UK market.

K E Lees

Mr K Lees
Chief Engineer
Delta Extruded Metals Co Ltd

**The Department of the Environment's Energy Efficiency Best Practice Programme** provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice Programme are shown opposite.

**Further information:**

For buildings-related topics contact:
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**Energy Consumption Guides:** compare energy use in specific processes, operations, plant and building types.

**Good Practice:** promotes proven energy efficient techniques through Guides and Case Studies.

**New Practice:** monitors first commercial applications of new energy efficient measures.

**Future Practice:** reports on joint R&D ventures into new energy efficiency measures.

**General Information:** describes concepts and approaches yet to be fully established as good practice.

**Fuel Efficiency Booklets:** give detailed information on specific technologies and techniques.

**Energy Efficiency in Buildings:** helps new energy managers understand the use and costs of heating, lighting etc.